APPLYING FINITE ELEMENT ANALYSIS IN STRUCTURAL DESIGN

The use of Finite Element Analysis for the Structural Engineer is an important advantage. The design of the structures not only benefit, but may require the use of this advanced analysis approach. The nature of structural components involves several concerns and requirements. Safety, reliability, strength, stiffness, and low cost all come in to the picture. Coupled with this, are the additional design requirements of interference, manufacturability, and overall function.

Traditionally, classical calculation methods were used as the primary tool for checking the strength characteristics of structures. Using the classical calculation methods many times has limitations as to the fit to the design geometry. By using finite element modeling as a primary analysis tool, the constraints of creativity are removed. All the requirements can now be evaluated and several variations of the design concept can be considered. The model can be used to quickly assess the strength and stiffness, and also the material usage of the component.

The following case example involves an evaluation of a transfer feed vertical post. This piece has been identified as a critical machine component of the transfer feed. The transfer feed mechanism is a three axis device that automatically loads a large transfer press that forms outer panels of a car or van. Having a stress failure of this component would be catastrophic. Additionally, the stiffness of the component is important for accurate positioning of the panels in the dies.

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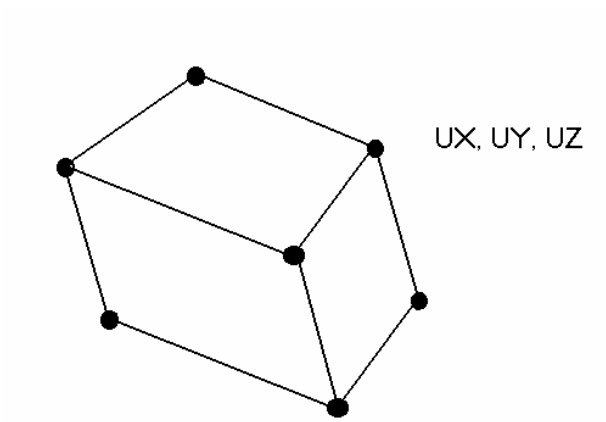
TF VERTICAL POST DESIGNS

C O N T E N T S

Introduction

The purpose of this analysis is to analyze the stiffness and stress characteristics of the Transfer Feed Vertical Post Designs. Two designs were analyzed and are referred to as the “Existing” and “New” designs. The loading for the designs was given to be 4950 pounds. This is the same value that was used in the previous Carriage analysis.

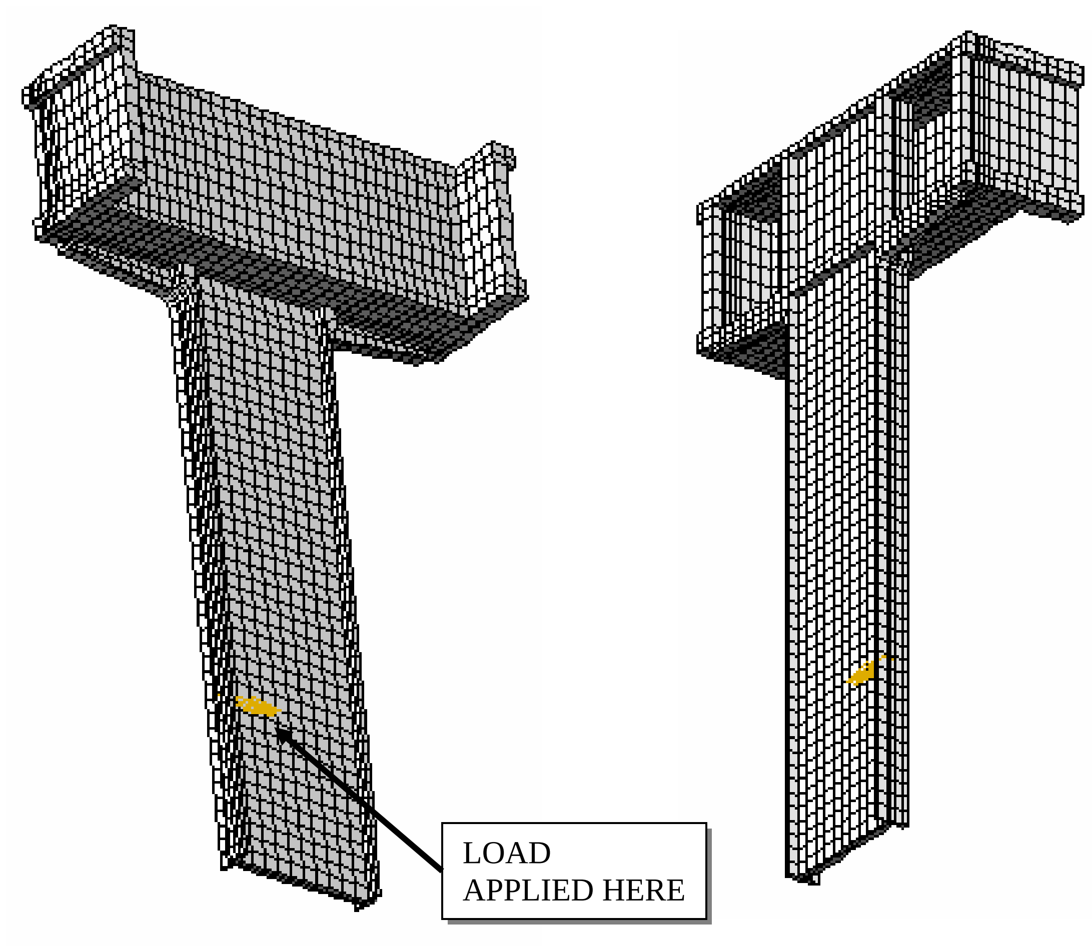
The analysis was done using a Finite Element Analysis (FEA) model. The element type for the models is a 3-D brick element. The brick elements primarily have 8 nodes which have 3 degrees of freedom each. Due to the symmetry of the geometry and loading, half models were used in each analysis.



Both designs were constructed using ASTM A36 Steel Plate. The following properties were used for the steel material.

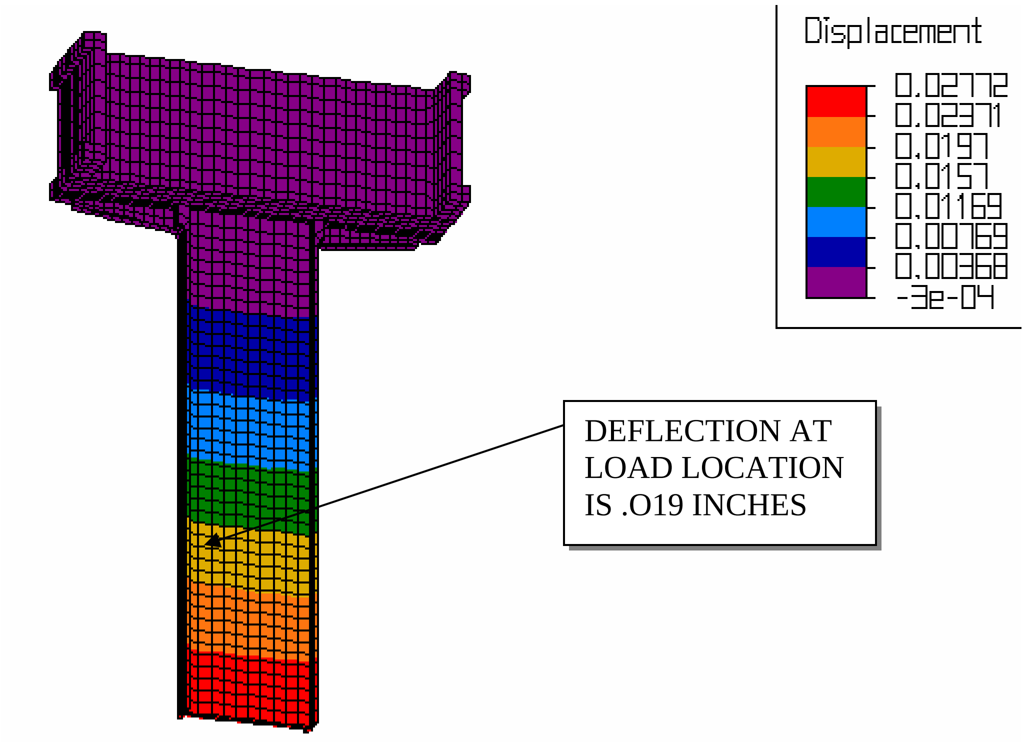
Modulus of Elasticity	(psi)	30,000,000
Poisson’s Ratio		.3

EXISTING POST – HALF MODEL



A HALF MODEL IS USED DUE TO THE SYMMETRY OF THE LOADING AND THE GEOMETRY. THE APPLIED LOAD IS 2475 POUNDS, WHICH IS EQUIVALENT TO 4950 POUNDS ON THE ENTIRE POST.

DEFLECTION CONTOURS (INCHES) – EXISTING POST

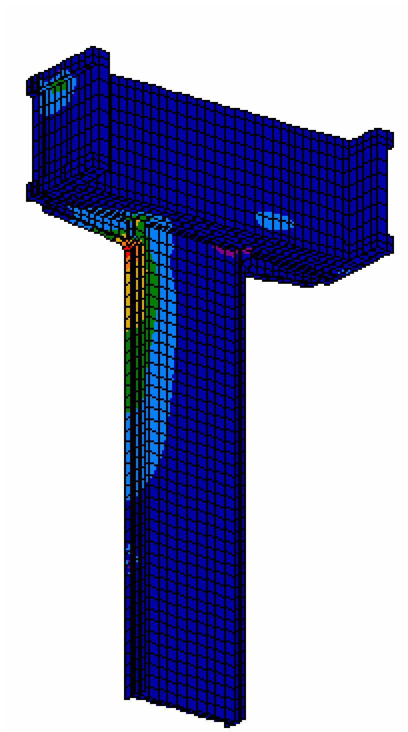


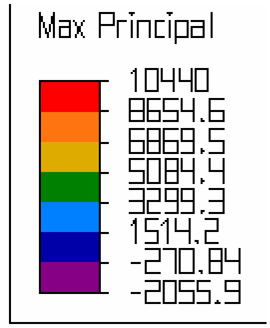
STIFFNESS APPROXIMATION

K = 4950 lbs / .019 inches = 260,526 lbs/in

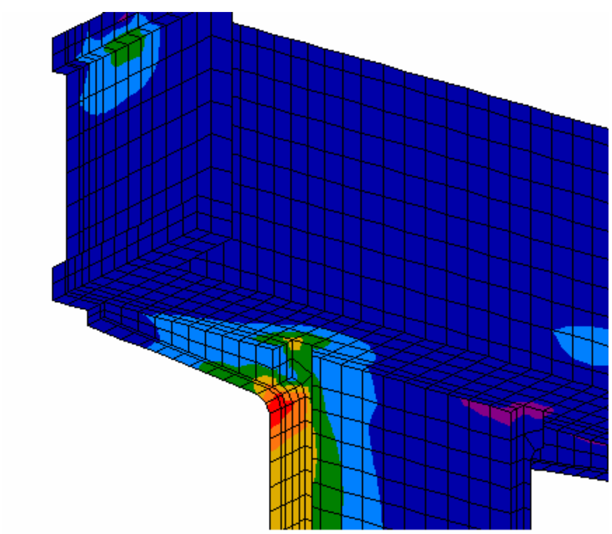
Note; this is only due to the Vertical Post. Other compliance in the system will reduce the stiffness.

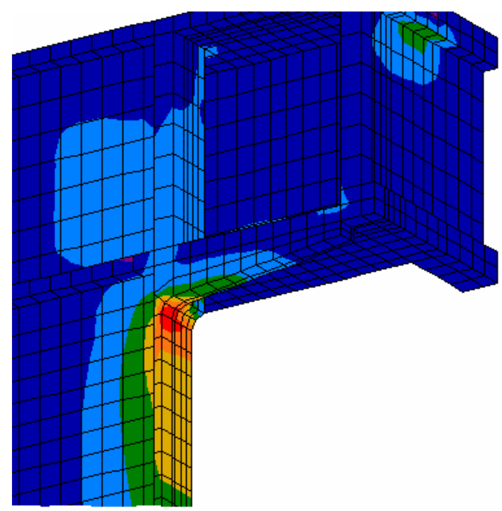
MAXIMUM PRINCIPLE TENSILE STRESS (PSI) – EXISTING POST



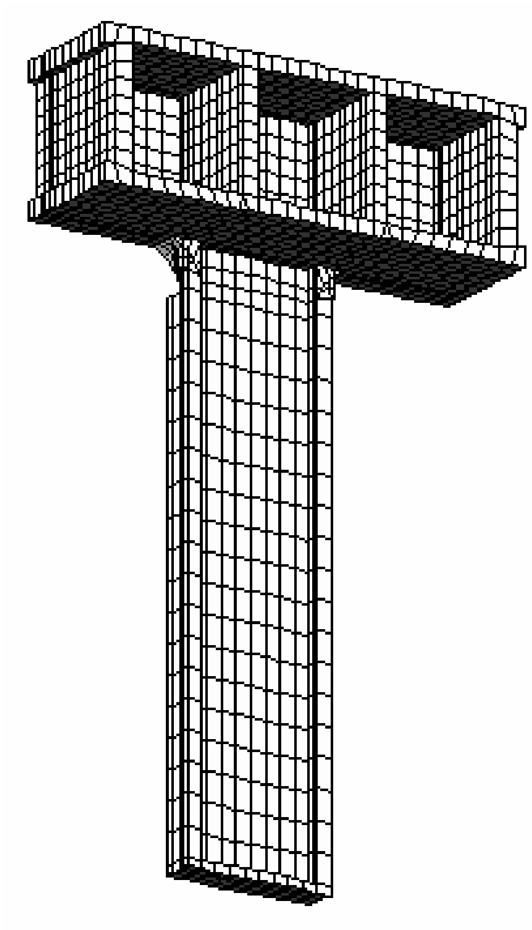


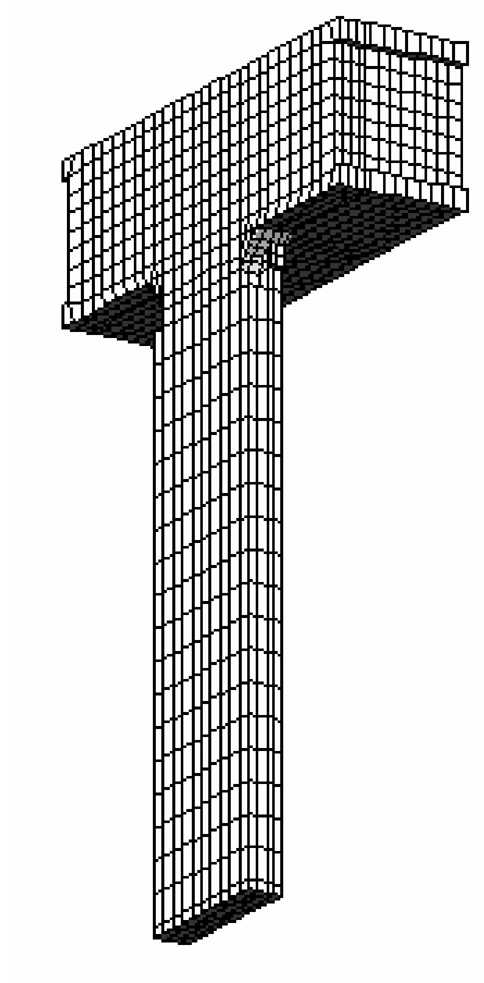
BACKSIDE OF POST



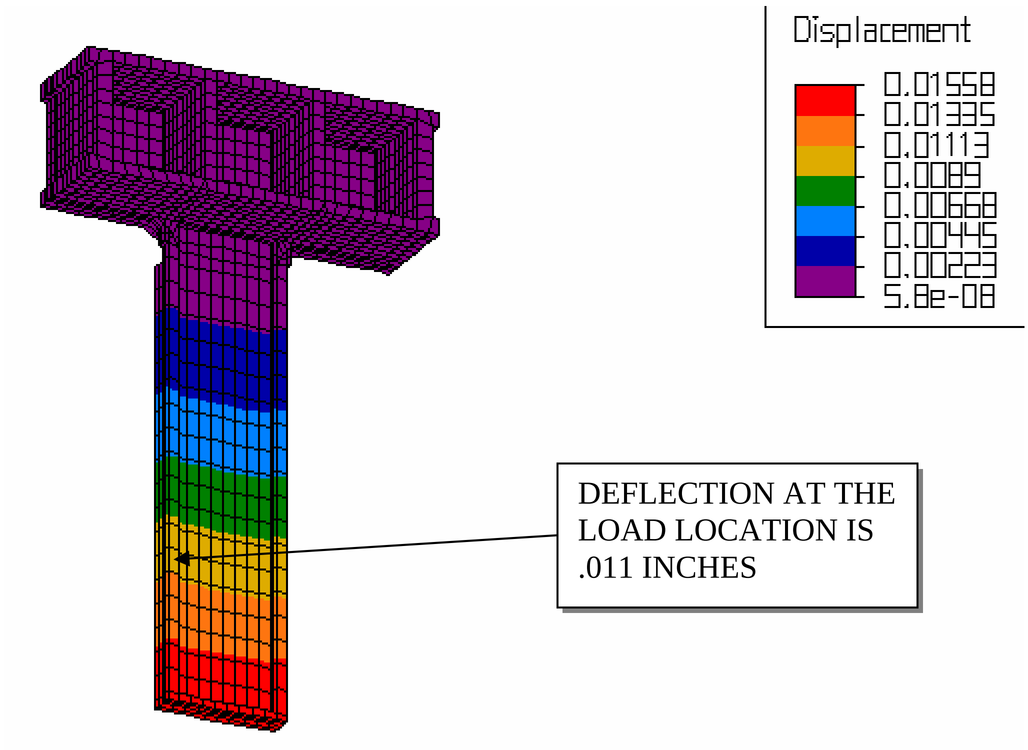


NEW POST – HALF MODEL





DEFLECTION CONTOURS (INCHES) – NEW POST

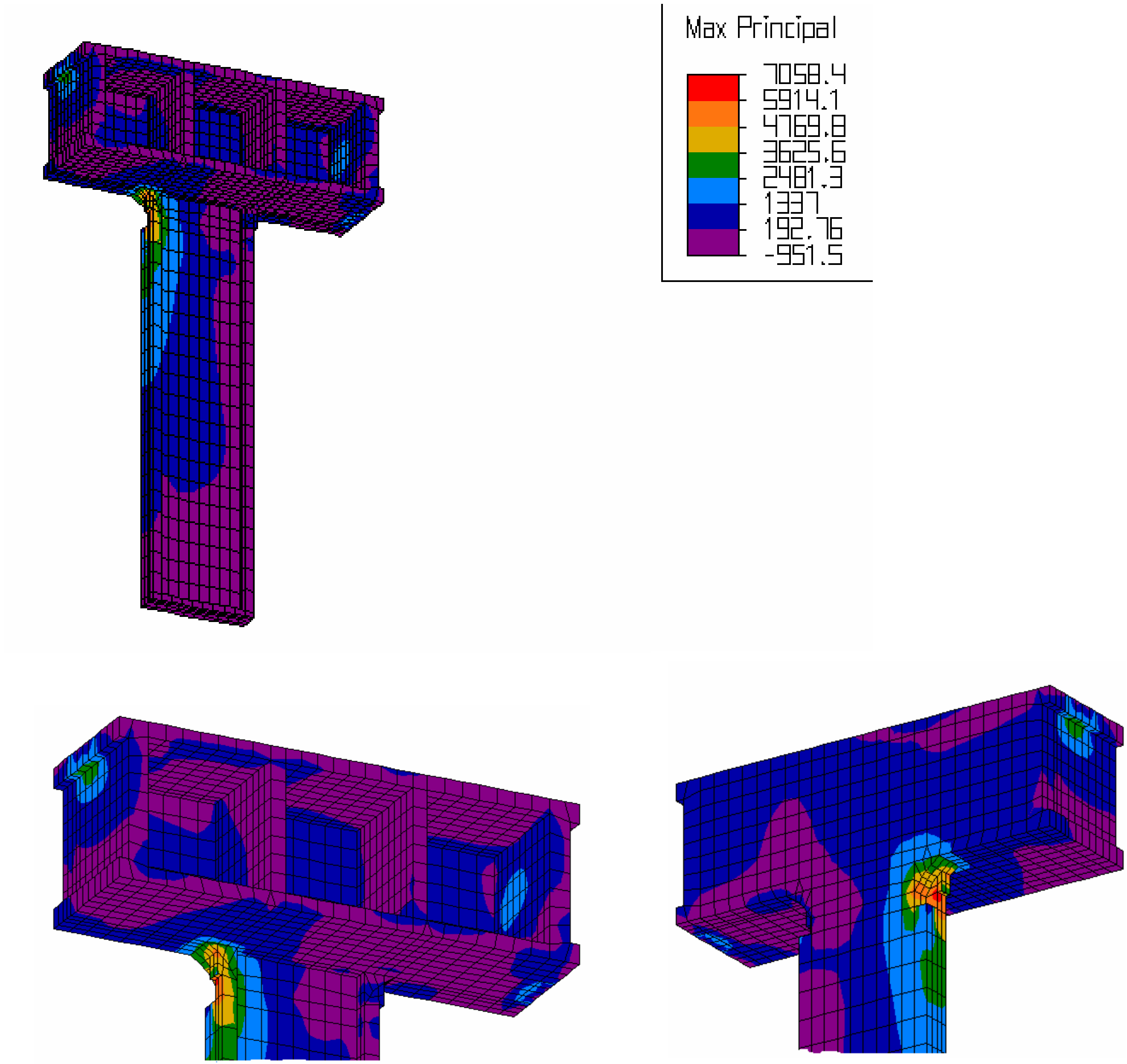


STIFFNESS APPROXIMATION

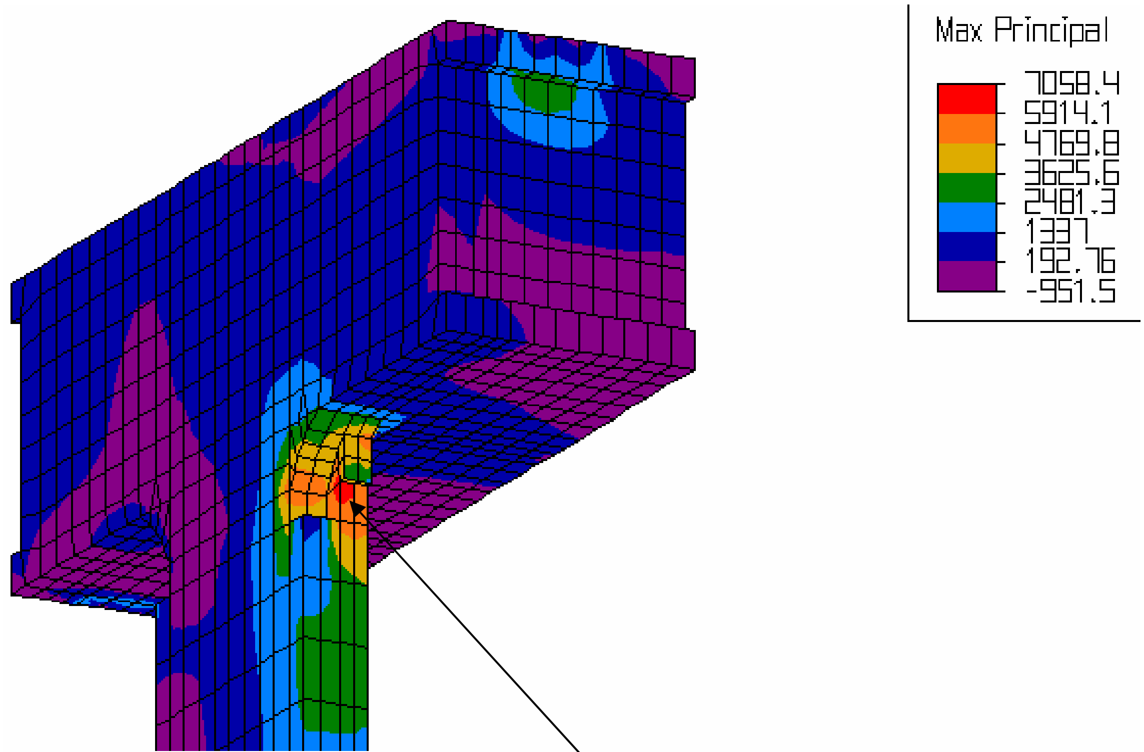
K = 4950 lbs / .011 inches = 450,000 lbs/in

Note; this is only due to the Vertical Post. Other compliance in the system will reduce the stiffness.

MAXIMUM PRINCIPLE TENSILE STRESS (PSI) – NEW POST



MAXIMUM PRINCIPLE TENSILE STRESS (PSI) – NEW POST



NOTE THAT THE PEAK STRESS IN THE T-PLATE IS ABOUT 5300 PSI. THE MAXIMUM STRESS OF 7000 PSI OCCURS AT THE RUNOUT OF THE MACHINING ON THE TAPPING PLATE.

Summary

The results of this analysis showed that the New Post Design is improved over the Existing Design. The following summary table shows the stiffness and stress comparison of the two designs.

	EXISITNG	NEW	PERCENT IMPROVEMENT
STIFFNESS (lb/in)	260,526	450,000	70 %
STRESS (psi)	10,440	7,058	48 %

Further benefit of the New design exists in the Weld joint design located in the area of the peak stress. The Existing design has a high stress area right in front of a load bearing weld (see page 4) where as the primary load bearing member of the New design is the continuous T-Plate.

The additional following items are a result of this analysis and are noteworthy:

1) In reviewing the CAD details of the New design, it indicated that the Tapping Plate (detail -005) calls out for a 1.75 cutout. However, in reviewing the Layout, the cutout appears to be 2.5 inches, which does clears the radius of the T-Plate.

2) As indicated on page 8, the peak stress is a result of a geometry stress riser at the end of the machining run-out. This magnitude can be reduced by lowering the end of the run-out or by putting a full radius at the end of the run-out. If this revision is made, our percent improvement would approach 90 %.

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The results of this evaluation have shown significant improvement in the strength and stiffness. Further benefit can also be obtained by a minor revision to the machining. For more information about the above analysis, or a free estimate, contact:

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Engr2062@cs.com

Please provide CAD data (dxf format) along with loading information.